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Measuring the Impact of and Demand for Agricultural Credit: An Annotated Bibliography*

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INTRODUCTION

Expanding formal agricultural credit use has been a major agricultural policy in many low income countries in recent years. The concessionary interest rates, high administrative costs and low repayment rates common in agricultural credit programs have meant substantial subsidies for continuing this policy. There is a growing concern, however, that these subsidies have not led to expected improvements in farm income, production, and income distribution. It has also been argued that certain policy instruments, especially concessionary interest rates, are responsible for the unsatisfactory performance of agricultural credit programs.

In this paper, we have assembled an annotated bibliography on selected literature dealing with (a) the impact of agricultural credit at the micro-level, and (b) the factors affecting demand for agricultural credit. The emphasis is on research dealing with low income countries. This collection represents some of the most important recent attempts we could identify to study these issues. A natural evolution in approach over time can be seen as researchers have tried increasingly more sophisticated techniques to improve their analyses.

Most of the studies covered in this bibliography are micro-level and empirical in nature. A number of theoretical analyses of the role of financial intermediation at the macro and micro-level have been included because of their importance in developing a conceptual framework for future empirical work in this

area. Only the more recent and easily accessible descriptive studies which dominate the empirical literature have been included. Many more descriptive studies are undoubtedly available as government reports or graduate student theses. The coverage of the more analytical studies, using econometric and programming methods, is more complete. A few U.S. based analyses are included to illustrate possible methodological approaches. In two recent review articles we have summarized some of the key conceptual and methodological problems and actual results encountered in empirical studies of credit impact and demand. These articles are also contained in this bibliography.

Although we have tried to be reasonably comprehensive in selecting key contributions to the literature, we may have missed some important items. We hope that users of this bibliography will inform us of those missing items so they can be incorporated into future issues of this bibliography.

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Agarwal, N. L. and R. K. Kumawat, "Potentialities of Increasing Farm Incomes Through Credit and New Technology," in Agricultural Situation in India, Vol. 29, No. 7, October 1974, ACTS No. 1308.1/

The study examined the affects of additional credit and new technology using linear programming based on data of 60 farmers in India in 1971-72. The study showed that additional credit at existing levels of technology increased income by 41 percent. Improved technology without credit decreased farm income by 38 percent, but with credit farm income increased by 73 percent.

Agarwal, N. L. and R. K. Kumawat, "Green Revolution and Capital and Credit Requirements in Semi Arid Region of Rajasthan," Indian Journal of Agricultural Economics, Vol. XXIV, Jan-March 1974, ACTS No. 972.

Objectives of the paper were: (1) to estimate the present capital needs and changes therein as a consequence of adoption of improved level of technology, (2) to estimate the credit requirements at the present as well as the improved level of technology, and (3) to examine the seasonal pattern of credit needs by different farm sizes for the semi arid region of Rajasthan. Linear programming models of typical small, medium and large farms based on data from twenty farmers for each size group in 1971-72 were developed.

Ahmed, Saad El Medani, "The Integration of Agricultural Credit and Marketing in the Gezira Scheme of the Sudan, with Special Reference to the 'Shail System,'" unpublished Ph.D. dissertation, Wye College, University of London, April 1977.

The study analyzed the factors affecting demand and supply of formal and informal credit based on 96 farmers in the Gezira Scheme. Cash flow analysis and linear programming were used to determine the farmer credit needs at different months of the year. The study proposed the integration of formal and informal credit sources and concluded that a 50 percent higher interest rate for formal loans would still increase farm income.

1/ The ACTS number listed after some items refers to a reference number in the Arnold Agricultural Credit Library at The Ohio State University.

Ahn, Choong Yong and Inderjit Singh, "Comparative Policy Simulations: Agricultural Development in Southern Brazil to 1985," in Modelling Economic Change, the Recursive Programming Approach, R. H. Day and A. Cigno (eds.), North-Holland Publishing Company, Amsterdam, 1978.

Authors presented results of projected regional development in Southern Brazil under alternative policy assumptions about agricultural prices and credit. Interest rate changes were assumed and the resulting impact was analyzed for output, resource use and income, both in the aggregate and by farm size.

Alexander, C. D., "Production Credit for Farms in a Javanese Village," unpublished Masters thesis, University of Hawaii, August 1975.

The study examined the potential impact of changes in operational policies of the agricultural credit program, BRI-BIMAS, in Indonesia on farm incomes and demand for credit. Linear programming models were specified for five representative groups of farms classified by farm size and liquid capital based on farm survey data of 62 farms in a village in West Java. The specific policy alternatives tested related to credit allocation rules, time of repayment, form (cash or kind) of credit, and price of credit.

Araujo, P. F. de, "An Economic Study of Factors Affecting the Demand for Agricultural Credit at the Farm Level," unpublished Masters thesis, Ohio State University, 1967.

The productivities of land, labor, and capital of borrowers and nonborrowers in 1965 were compared based on a sample of 132 farms in Sao Paulo, Brazil. Econometric analysis of the factors affecting demand for credit did not show any significant impact for interest rate. Outstanding debt, volume of new investments, and level of education were positively related to credit demand. Demand for credit declined as the volume of internal funds and the ratio of debts to assets increased.

Baker, C. B., "Credit in the Production Organization of the Firm," American Journal of Agricultural Economics, Vol. 50, No. 3, August 1968, ACTS No. 543.

The author argued that the traditional equilibrium conditions must be modified to consider cost of financing. Credit, defined as borrowing capacity, constitutes a source of liquidity. Borrowing generates a cost from loss of liquidity and interest charges. The prices of inputs and outputs used to determine optimal resource allocation must reflect these costs. Hypothetical linear programming models were presented to demonstrate these concepts.

Baker, C. B., "Financial Organization and Production Choices," American Journal of Agricultural Economics, Vol. 50, No. 5, No. 5, December 1968.

The author argued that financial cost must be added to prices in optimum combination of resources. A multiperiod linear programming model was developed to test how alternative forms of land acquisition, mortgage, land purchase contract, and leasing affect borrowing and firm growths. No empirical results were reported, but specific studies were cited to show relevant aspects of the model.

Baker, C. B., "Role of Credit in the Economic Development of Small Farm Agriculture," in Small Farmer Credit, Analytical Papers, AID Spring Review of Small Farmer Credit, Vol. XIX, No. SR119, June 1973, Washington, D.C. 20523, ACTS No. 902.

Author discussed financial behavior of small farmers emphasizing reserves management with and without a small farmer credit program (SFCP). SFCP loans were assumed to be less valuable than cash or moneylender credit because they are frequently restricted to agricultural production, involve more formalities, may not be as timely, and have long-term uncertainty. A hypothetic linear programming model was presented to show concepts.

Baker, C. B. and Vinay K. Bhargava, "Financing Small Farm Development in India," Australian Journal of Agricultural Economics, Vol. 18, No. 2, August 1974, pp. 101-118, ACTS No. 932.

Authors tested concept of financial reserves management for a sample of small farms in District Badaun, U.P., India. A linear programming model of a typical small farm was constructed to include borrowing from both moneylenders and small farmer credit programs (PSCP). Various values were given to unused cash and borrowing capacity. Results showed that the optimum solutions of models with values assigned for unused liquidity were closer to observed farm plans than were the solutions to models without this concept.

Baker, C. B. and G. D. Irwin, "Effects of Borrowing from Commercial Lenders on Farm Organization, with Particular Reference to Fertilizer, Buildings, Machinery, Livestock and Operating Expense," University of Illinois, Agricultural Experiment Station, Bulletin 67, April 1961.

Study compares optimum use of farm resources with lending limits set by lenders. Cobb-Douglas production functions were adjusted to data from 140 cash grain farmers and 86 livestock farmers to determine optimum resource use. Forty-two agricultural lenders were requested to indicate lending limits for

various expenditures. Results showed lenders would overlend on asset-generated loans for feeder cattle, machinery and buildings, but underlend for operating expense.

Becker, W. S., "Agricultural Credit and Colombia's Economic Development," unpublished Ph.D. dissertation, Louisiana State University, 1970.

To analyze the effect of credit on crop productivity in Colombia, a Cobb-Douglas production function with the value of agricultural credit specified as one of the independent variables was estimated using department-level data from the 1960 National Census. The author found a higher marginal value product of credit than its cost and concluded that increasing credit use could raise agricultural output.

Bishop, C. E., "Programming Farm-Nonfarm Allocation of Farm Family Resources," Journal of Farm Economics, Vol. 38, No. 2, May 1956, pp. 396-407.

Author reported on a study of part-time farms in North Carolina. A linear programming model of a typical farm was developed, including minimum family subsistence. Activities included crops, livestock and nonfarm employment. With tight capital constraints, large amounts of nonfarm employment entered model. When the credit constraint fell, nonfarm employment also fell.

Boehlje, Michael D. and T. Kelly White, "A Production-Investment Decision Model of Farm-Firm Growth," American Journal of Agricultural Economics, Vol. 51, No. 1, February 1969, pp. 546-563.

Authors studied farm-firm growth including investment and production decisions. A multi-period linear programming model was used for a hypothesized central Indiana farm with a ten-year planning horizon. Optimizing criteria included maximizing net worth and discounted disposable income, which produced different growth paths. Credit was constrained by collateral rather than profitability. Net worth maximization resulted in heavy debt use.

Cannete, C. C., "The Income Level and Income Distribution Impacts of Masagana 99 Program in Central Luzon, Philippines," unpublished Ph.D. dissertation, Purdue University, 1978.

The study compared input use, yield, farm income, income distribution patterns, and degree of income concentration between participants and non-participants in the Masagana 99 program. The analysis was further classified by irrigation and farm size. Production functions were estimated and compared between the two groups.

Cardoso, Joao Luiz, "Credito Rural Em Condicoes de Diferentes Niveis Tecnologicos," unpublished M.S. thesis, Universidade de Sao Paulo, Piricicaba, 1976.

Objective of study was to compare the factors associated with credit use in an advanced and a more backward region in the State of Sao Paulo. Almost 80 percent of the farmers in the advanced area used credit compared to just over 50 percent in the backward region. Linear, Cobb-Douglas, and Ulveling-Fletcher regression models were estimated. Value of land and buildings, value of agricultural production, length of time as bank customer, age of operator, value of production inputs used and borrowing for investment purposes were found to explain level of borrowings.

Carillo-Huerte, M. M., "Agricultural Credit, Insurance and the Adoption of Innovations by Mexican Farmers," unpublished Ph.D. dissertation, Vanderbilt University, 1976.

The thesis analyzed the factors affecting adoption of innovations and evaluated the performance of the present agricultural credit and insurance program as a means for promoting adoption of innovations in Mexico. Education, income and wealth, farm size, and farmer's accessibility to input and product markets were important explanatory variables. The case study of a small Mexican agricultural community suggested that farmer's accessibility to input markets through credit was the single most important factor affecting adoption of innovations.

Chung, K. W. and Mokhtar Tamin, "The Effect of Capital Availability and Credit on the Use of Resources in Padi Farming," Kajian Ekonomi Malaysia, Vol. VIII, No. 2, December 1971.

Based on a farm survey of 212 farms in the Muda Irrigation Project in Malaysia, separate Cobb-Douglas production functions were estimated for three farm groups classified according to a capital availability index (sum of income and credit per unit area). The index of capital availability did not seem to have any effect on the ability of farms to equate marginal value product to input price.

Colyer, D. and G. Jimenez, "Supervised Credit as a Tool in Agricultural Development," American Journal of Agricultural Economics, Vol. 58, No. 4, November 1971, ACTS No. 417.

The impact of supervised credit programs in Colombia was analyzed by comparing levels of input use and productivity and by estimating production functions before and after the program and between participants and non-participants. Based on the

significant coefficient for credit and the higher production coefficient of operating capital among participants derived from the production function model, the authors concluded that supervised credit is an important factor in increasing agricultural productivity.

Cordova, V., P. Masicat and R. W. Herdt, "Use of Institutional Farm Credit in Three Locations of the Philippines: 1975-1977," unpublished paper, International Rice Research Institute, Laguna, Philippines, 1978, ACTS No. 1849.

This study examined the following questions: whether the Masagana 99 Credit Program effectively reached the mass of farmers; whether farm size, tenure, or location affected the use of credit by farmers; whether the use of credit was associated with increased output; and why some farmers did not borrow from the credit institutions. The descriptive analysis of these questions used a series of five surveys covering 150 farms in Nueva Ecija, Laguna, and Camarines Sur.

Curtis, R. V., "Borrowed Capital and the Economic Development of Agrarian Reform Farms in Northern Honduras," unpublished Ph.D. dissertation, University of Oregon, 1975.

The study estimated the amount and time distribution of borrowed capital necessary for a hypothetical farm under an agrarian reform program to develop into a viable farm enterprise. A ten year dynamic linear programming model was constructed to examine the economic benefits - production, land use, and employment - associated with alternative loan sizes and duration. The author recommended a lower loan limit because given a fixed amount of loanable funds, global benefits would be larger due to the higher average productivity of borrowed capital and the possibility of servicing a larger number of beneficiaries.

Daines, S. R., "Guatemala Farm Policy Analysis: The Impact of Small Farm Credit on Income, Employment, and Food Production," Analytical Working Document No. 10, Bureau for Latin America, AID, Washington, April 1975, ACTS No. 1194.

The study evaluated the effect of the Bandesa Credit Program on food production, net income and employment based on farm survey data of 800 borrowers and 800 nonborrowers in Guatemala. Levels of income, employment, and productivity of land, labor, and capital between borrowers and nonborrowers were compared by farm size and by region. Sources of difference in output due to differences in crop mix, yield, price and area between borrowers and nonborrowers were also estimated.

David, C. C. and R. L. Meyer, "Measuring the Farm Level Impact of Agricultural Loans in Low Income Countries: A Review Article," paper presented at Workshop on Rural Financial Markets and Institutions, Wye College, England, June 12-14, 1979, ESO 602, Department of Agricultural Economics and Rural Sociology, Ohio State University, Columbus, Ohio, May 1979.

The paper summarized some of the key conceptual problems involved in evaluating the impact of agricultural credit programs. Alternative methodological approaches were analyzed and actual results discussed only to illustrate the type of findings encountered. After presenting a conceptual framework for identifying the impact of credit on farm resource allocation, descriptive, econometric and mathematical programming studies were reviewed. Areas of research to improve future estimates of benefits expected and obtained from agricultural credit were suggested in the final section.

David, C. C. and R. L. Meyer, "A Review of Empirical Studies on Demand for Agricultural Credit," unpublished paper presented at the Second International Conference on Rural Finance Research Issues, Calgary, Canada, August 29-September 1, 1979, ESO #603, Department of Agricultural Economics and Rural Sociology, Ohio State University, Columbus, Ohio, May 1979.

The authors first presented a conceptual framework for analyzing the factors affecting demand for credit. Various studies of short and long-run projections of agricultural credit demand were reported followed by an evaluation of econometric and mathematical programming estimates of demand functions. The economic implications of the results of past studies and potential areas of research and improvements in the methodology were discussed in the final section.

Day, Richard H. and Inderjit Singh, Economic Development as an Adaptive Process: The Green Revolution in the Punjab, Cambridge University Press, Cambridge, 1977.

Punjab agriculture was modelled with a recursive linear programming model. Various borrowing and savings activities and constraints were included. The interest rate elasticity of demand for debt was estimated. Demand was shown to become more elastic over time as capital goods were largely acquired early in the 1955-1980 period studied.

Dean, G. W. and Michele de Benedictis, "A Model of Economic Development for Peasant Farms in Southern Italy," Journal of Farm Economics, Vol. 46, No. 2, May 1964, ACTS No. 548.

The study used dynamic linear programming to derive normative development plans through time for small land reform farms in the newly irrigated Metaponto plain of southern Italy. The productivity of government investment in low interest loans and direct grants for orchard development was also measured. A high potential return of about 85 percent was obtained for this government policy.

El Nasser, M. M., "The Market for Production Credit Associations' Loans," unpublished M.S. thesis, Ohio State University, 1965.

To explain the relatively low interest rates charged on non-real estate loans by Production Credit Associations, this study estimated supply and demand functions based on aggregate U.S. data for 1934-1959. Demand variables considered were rate of interest, volume of internal funds, technology index, expected product prices, size of loan, difference between interest rate charged by commercial banks on non-real estate agricultural credit in Production Credit Associations, and production costs. Except for the interest rates, all the explanatory variables were statistically significant and with the expected direction of relationship.

Engler, Joaquin J. de Camargo and Richard L. Meyer, "Trigo: Producao, Precos e Produtividade," Pesquisa e Planejamento Economico, Vol. 3, No. 2, June 1973, pp. 341-368, ACTS No. 813.

Study analyzed impact of price and credit policies on wheat farms in Southern Brazil. A linear programming model was used to analyze the impact of interest rate and wheat and livestock prices on a typical large farm. The optimal combination of enterprises was relatively insensitive to increased interest rates on formal credit.

Fisher, I., The Theory of Interest, MacMillan Co., New York, 1930.

This book represents a seminal attempt to provide a theory explaining interest rate determination. The interest rate expresses a price of exchange between present and future income. The author argued that interest rate depends on the subjective time preference between present and future income and the objective investment opportunity.

Galbis, V., "Financial Intermediation and Economic Growth in Less-Developed Countries: A Theoretical Approach," Journal of Development Studies, Vol. 13, No. 2, January 1977, ACTS No. 1469.

This paper presented a theoretical framework of the role of financial intermediation in the process of economic growth. It showed within a two-sector model that high (equilibrium) real interest rates are growth promoting by shifting resources for the traditional low yielding investments to investments in the modern technological sectors. Implications of artificially low interest rate policies prevailing in most LDCs on inflation and income distribution were also analyzed.

George, K. M., "Nature and Pattern of Demand for Agricultural Credit," Financing Agriculture, Vol. 9, No. 2, 1977.

Based on data collected from a sample of 100 farm households in Ernakulam District in Keraba, India, an attempt was made to examine the nature of demand for farm credit vis a vis irrigation facilities at the micro level. The study indicated strong and positive correlation between irrigation facilities and the demand for credit as well as between fertilizer consumption and demand for production credit especially in the more progressive areas.

Gupta, L. C. and G. Singh, "Short-term Credit Requirements of an Area (An Approach to Better Estimates)," Agriculture and Agro-Industries Journal, Vol. 7, No. 2, Feb. 1974.

The authors estimated potential demand for short term credit under improved production technology by farm budget techniques. Estimates of capital and credit requirements for representative farms classified by farm size and irrigation under the traditional technology were obtained based on a farm survey in three Indian villages in 1969/70. By making rational adjustments based on local extension's recommendation for the area, and assuming a certain proportion of capital requirements to be funded by credit, the optimal level of credit under the improved technology were estimated for each type of representative farm and for the whole region.

Gyekye, A. B., E. T. Acquah and C. D. Whyte, "An Evaluation of Institutional Credit and Its Role in Agricultural Production in Ghana," Bureau of Economic Research and Development, Virginia State College, 1977.

The authors evaluated the role of institutional credit on agricultural production in Ghana. A modified Cobb-Douglas production function with production elasticities varying with credit use was estimated based on aggregate data from 1962-1974. Only labor was found to be a significant input in production and use of credit did not have any significant impact on any of the production elasticities.

Hadiwigeno, S. S., "Potential Effects of Modification in the Credit Program for Small Farms in East Java, Indonesia," Unpublished Ph.D. dissertation, University of Illinois, 1974.

The study investigated the effects of the Bimas credit program on the income and crop mix of farms in five different types of villages in Indonesia. A linear programming model was developed to simulate the average farmer's response to a no-Bimas compared to two alternative Bimas credit program packages.

Heidhues, Theodore, "A Recursive Programming Model of Farm Growth in Northern Germany," Journal of Farm Economics, Vol. 48, No. 3, Part I, August 1966, pp. 668-684, ACTS No. 1853.

Author used a recursive programming model of an individual farm to study savings, investment and growth. Objective function maximized accumulation of investment capital, subject to predetermined consumption. Alternative pricing policies were assumed and the resulting impact on firm growth analyzed.

Herr, W. McD., "Understanding Changes in Non-Real Estate Farm Debt," Agricultural Finance Review, Vol. 28, November 1967.

The study attempted to explain annual fluctuations in non-real estate farm debt outstanding in terms of the supply of internal funds and changes in the cash expenditures in the farm sector. Both of these explanatory variables were found to be significant and with the expected signs in the regression analysis based on U.S. regional data from 1949-1965.

Hesser, L. F. and E. Schuh, "The Demand for Agricultural Mortgage Credit," Journal of Farm Economics, Vol. 44, No. 5, December 1962.

The authors estimated a demand function for farm mortgage credit based on U.S. aggregate data from 1921 to 1959. A simultaneous equation model was formulated and estimated by the limited information simultaneous equation technique. The independent variables were interest rates, savings (representing supply of internal funds), expected output and input prices, wages, technology, mortgage debt outstanding, and number of farm transfers. Demand for mortgage funds was found to be highly elastic with respect to interest rate.

Hirschleifer, J., "On the Theory of Optimal Investment Decision," Journal of Political Economy, Vol. 66, No. 4, August 1958.

The author presented a theoretical analysis of investment decisions where the ultimate purpose of investment is to increase consumption. The implications of the theory under conditions of perfect and imperfect capital markets were discussed. The author also explained the factors affecting multiperiod investments.

Husain, T. and R. Inman, "A Model for Estimating the Effects of Credit Pricing on Farm Level Employment and Income Distribution," Bank Staff Working Paper No. 261, World Bank, July 1977, ACTS No. 1773.

The paper evaluated the effects of changes in interest rate, farm management decision rule, and output price on farm production mix, technology choice, employment, and incomes of different groups of beneficiaries. A linear programming model was constructed for a 1600 ha. irrigated farm in a village of 350 households.

Irwin, George D., "A Comparative Review of Some Firm Growth Models," Agricultural Economics Research, Vol. 20, No. 3, July 1968, pp. 82-100.

Author analyzed concept of growth of farm firms with emphasis on internal and external flow of funds. Applications of multiperiod linear programming, recursive programming and simulation techniques applied to the study of firm growth were reviewed. The details of the methods for modelling financial activities were analyzed in each application. Suggestions for additional research were given.

Karnik, K. C., "Factors Influcing Use of Credit in American Agriculture," unpublished Ph.D. dissertation, University of Missouri, 1961.

The study investigated the relationship between amounts of short and long term farm credit and value of farm real estate, commodity prices, income, farm expenses, resources of credit institutions, and changes in technology based on time series data from 1914 to 1958 in nine selected states in the U.S. Value of farm real estate and expansion in farm size were important explanatory variables of long term credit. Short term credit was positively related to production expenditures and change in technology, but negatively related to income.

Kumar, P., P. K. Joshi and M. A. Muralidharan, "Estimation of Demand for Credit on Marginal Farms - A Profit Function Approach," Indian Journal of Agricultural Economics, Vol. 23, No. 4, October-December 1978.

The article reported on credit use among 50 small farm-households in Western Uttar Pradesh, India. Authors used a profit function model to estimate elasticities of demand for crop loans with respect to interest rates, and prices of output and inputs. They concluded that credit demand is elastic for products and input prices but inelastic for interest rates.

Ladman, J., "A Model of Credit Applied to the Allocation of Resources in a Case Study of a Sample of Mexican Farms," Economic Development and Cultural Change, Vol. 22, No. 4, January 1974, ACTS No. 864.

A linear programming model was developed to estimate a demand schedule for short-term credit for the farmer, to show by way of credit, resource, and product profiles the role of additional units of credit in the farmer's production program, and to examine, on the supply side of credit, the effects of non-price credit rationing. The model was applied to a case study of typical farms in Zaragoza County in Mexico.

Lerttamrab, P., "Liquidity and Credit Constraints: Their Effect on Farm Household Economic Behavior - A Case Study of Northern Thailand," unpublished Ph.D. dissertation, Stanford University, 1976.

The financial sector was incorporated into a subjective equilibrium model of a farm household by introducing liquidity and credit constraints. Based on 1973 farm survey in Chiang Mai, a system of household behavioral functions - profits, rice supply, non-rice supply, labor demand, animal labor and tractor input demand, and chemical demand were generated for the estimated quadratic profit functions for three categories of liquidity constraint. Credit constraint appeared to limit farm-households' responsiveness to market forces and ability to maximize utility.

Lins, David, "Mathematical Models in the Study of Agricultural Finance: A Nonmathematical Description," Agricultural Finance Review, Vol. 29, February 1969, pp. 6-14, ACTS No. 198.

Author described characteristics of optimizing and non-optimizing models as applied to agricultural finance. Single-period linear programming, recursive linear programming, dynamic or multi-period linear programming, source-use analysis and simulation are discussed regarding assumptions and nature of solutions.

Lins, David A., "Determinants of Net Changes in Farm Real Estate Debt," Agricultural Economic Research, Vol. 24, January 1972.

Supply and demand functions for explaining net changes in farm real estate debt by lending institutions in the U.S. were estimated econometrically based on aggregate data from 1949-1969. Capital appreciation, net farm plus nonfarm income, and the ratio of money balances to gross production expenses were specified in the demand equation. Changes in supply were increased by the yield differential between farm and nonfarm investments and availability of mortgage funds. Elasticity estimates indicated that demand was more sensitive to changes in income than to capital appreciation, while supply was sensitive to changes in yield differentials.

Long, M. F., "Why Peasant Farmers Borrow," American Journal of Agricultural Economics, Vol. 50, No. 4, November 1968, ACTS No. 48.

The author presented a model of farm borrowing behavior under conditions of certainty and uncertainty. The empirical part of the study involved the estimation of the relationship between demand for credit and interest rate, transitory income, family expenditures, investment, and wealth, using survey data of 672 farmers in India in 1951-52. Interest rate was only marginally significant, but all other variables, especially investment, were highly significant and the signs of their coefficients conformed with expectations.

Mandac, A. M. and R. W. Herdt, "Economic Inefficiency as a Constraint to High Rice Yields in Nueva Eciya, Philippines," Paper presented at Saturday Seminar, International Rice Research Institute, Laguna, Philippines, 1978.

The authors measured the degree of technical and allocative inefficiency of 56 farmers in Nueva Ecija using a combination of experimental data, record keeping, and survey data. Regression analysis was used to identify the factors affecting technical and allocative inefficiency separately. It was found that credit and measures of financial constraint were significant explanatory variables of allocative inefficiency. Farmers who did not borrow were significantly less allocatively efficient than farmers who borrowed.

Melichar, E., "Financing Agriculture: Demand for and Supply of Farm Capital and Credit," American Journal of Agricultural Economics, Vol. 55, No. 2, May 1973, ACTS No. 1257.

Demand for agricultural credit in the U.S. was projected using the flow of funds approach. Based on historical trends in land transfers, purchases of capital equipment, and ratio of internal financing to cash flow between 1950-1971, future trends in the demand for agricultural credit were derived residually.

Meyer, Richard L., "Financing Agrarian Reform Through Beneficiary Payments," A. E. Research 72-4, Department of Agricultural Economics, Cornell University, April 1972, ACTS No. 592.

Study analyzed ability of agrarian reform beneficiaries to pay for land received. Linear programming models were developed to estimate debt repayment capacity for six farms representing a broad range of circumstances. Capital requirements were estimated for current operations and future investments required to increase labor absorption and debt servicing capacity.

Naseem, M., "Credit Availability and the Growth of Small Farms in the Pakistan Punjab," Food Research Institute Studies, Vol. XIV, No. 1, 1975, ACTS No. 1211.

This paper explored how the relationship between farm size, technological change, and the ability to accumulate was affected by government policies regarding agricultural credit, interest rates, and product prices. A multiperiod programming model for the Punjab region in Pakistan was developed using data from a sample of small farms in Sahival District.

Nehman, G. I., "Small Farm Credit Use in a Depressed Community of Sao Paulo, Brazil," Unpublished Ph.D. dissertation, Ohio State University, 1973.

The study determined how farmers in a depressed area of Sao Paulo, Brazil, were served by various types of lenders, identified the economic factors affecting the allocation of credit among farms and examined how credit can increase the efficiency of resource use in agriculture. To achieve the last objective, separate production functions were estimated for borrowers and nonborrowers based on cross-section survey data of 150 farmers.

Nyanin, O. O., "Credit and Small Farmers in South Korea, 1968-70," Unpublished M.S. thesis, Ohio State University, 1978.

The study documented the sources and uses of agricultural credit in Korea based on panel data of 438 farms from 1968 to 1970. Differences in levels of input use, farm output, and household income between borrowers and nonborrowers were analyzed. The study also attempted by econometric techniques to identify the factors affecting credit use.

Ohio State University Research Team, Farm Growth in Brazil, Department of Agricultural Economics and Rural Sociology, Columbus, June 1975.

Several features of recent farm growth patterns were analyzed. Emphasis was given to credit use and associated impact at the farm level. A recursive linear programming model emphasizing farm size decomposition was used to analyze alternative policy simulations including changes in interest rates and borrowing limits. The results were analyzed in the aggregate and by farm size.

Oliveira, J., "Derived Demand for Agricultural Credit - A Multi-period Investment Model," Unpublished Ph.D. dissertation, Purdue University, May 1977, ACTS No. 1503.

The study analyzed the impact of changes in interest rates, discount rates, inflation rates and grace period on credit demand by a typical Brazilian farm household using a linear programming model with twelve planning periods. Results indicated somewhat inelastic demand response to interest rates, except at very high levels. Inflation, discount rates, and grace period shifted demand for credit. Inflation also affected interest elasticity of credit demand. The effects of these factors on farm income were also analyzed.

Onchan, T., "Research on Credit Needs of Thai Farmers," Paper presented at the Conference on Rural Finance Research, San Diego, California, 1977, ACTS No. 1483.

The paper reviewed available empirical evidence about the characteristics of demand for credit among Thai farmers. Since available studies were primarily descriptive, the author emphasized the need for more analytical studies of the factors affecting demand for credit to provide a basis for projecting aggregate credit demand. The use of programming models to fill this need was proposed.

Pani, P. K., "Cultivator's Demand for Credit: A Cross Section Analysis," International Economic Review, Vol. 7, No. 2, May 1966, ACTS No. 235.

Demand functions for rural credit were estimated based on district-level Indian data for 1951-52, 1956-57, 1957-58, 1958-59 and 1959-60. The model specified credit as a linear function of interest rate, capital expenditure, family expenditures and value of assets. Except for value of assets, all the variables showed statistically significant coefficients and expected signs. Elasticity of demand with respect to interest rate was generally less than unity; it was more elastic for high income than for low income groups. The coefficient for capital expenditure was higher than for family expenditures for high income groups but the converse was true for the low income group.

Patrick, George F., "Efectos de Programas Alternativos de Governo Sobre a Agricultura do Nordeste," Pesquisa e Planejamento Economico, Vol. 4, No. 1, February 1974, pp. 49-82.

Author tested impact of alternative government policies to improve farm income in impoverished areas of Northeast Brazil. Linear programming models were developed of representative farms in three counties. Policy simulations included changes in interest rate for formal credit. Interest rate had little effect, especially for small farmers.

Peres, F. C., "Derived Demand for Credit Under Conditions of Risk," Unpublished Ph.D. dissertation, Ohio State University, 1976.

The study developed a quadratic programming model which incorporated conditions of risk and inflation to simulate farm decision making in the Ribeirao Preto region of the State of Sao Paulo, Brazil. Demand curves for short-term credit for small and large representative farms were estimated. It appears that larger farms were characterized by relatively more excess demand for credit than smaller farms.

Rao, P. B., The Economics of Agricultural Credit-Use in Southern Brazil, Andhra University Press, Andhra Pradesh, India, 1973.

The need for production credit was examined by comparing marginal value products of operating and fixed capital to their respective marginal costs (including the cost of credit) based on 452 farms surveyed in Southern Brazil in 1967. A demand function for credit was also estimated econometrically with the following independent variables: consumption expenditure, operating expenses, capital expenditures, and assets.

Rice, E. P., "Problems and Results in Evaluating Agricultural Credit Projects," Paper presented at the Conference on Rural Finance Research, San Diego, California, 1977, ACTS No. 1493.

The paper discussed the problems encountered by the Operations Evaluation Department of the World Bank in ex post evaluations of agricultural credit projects funded by the Bank. The central problem is the lack of information on changes in activities on borrower farms after the loan is made. Conceptual problems include the attribution issue, i.e., how to identify the changes in farm activities that can be attributed to the inputs purchased with project credit and the substitution issue, i.e., how to take into account the possibility that the farmer would have used own funds or other sources of finance to purchase the same inputs funded by the credit project.

Roe, A. R., "Some Theory Concerning the Role and Failings of Financial Intermediation in Less Developed Countries," Domestic Finance Studies No. 50, Development Economics Department, World Bank, May 1978.

The purpose of the paper was to clarify the fundamental role of a financial sector, the factors which limit its effectiveness, and the benefits which might accrue from improving it. After presenting the theoretical framework, the paper discussed the impact of uncertainty and imperfections in the capital market (imperfect information, interest rate and other quantitative restrictions) on financial intermediation and distribution of credit. The nature of interaction between formal and informal financial markets suggested by the theoretical analysis was also explained.

Rosegrant, M., "Choice of Technology, Production and Income for Philippine Rice Farmers: Agricultural Policy and Farmer Decision Making," Unpublished Ph.D. dissertation, University of Michigan, 1977.

A multi-season simulation model was developed to investigate the impact of government policies (interest rate, institutional loan limit, fertilizer subsidy, etc.) on farm productivity, income and factor use. The model attempted to take account of yield variability and farm-household interdependence. The study concluded that demand for credit is much more responsive to changes in loan limits than interest rates. An extension of repayment period coupled with emergency consumption loans in case of crop failure will likely increase productivity and income in the long run.

Sarma, P. V. and K. Siva Prasad, "Demand for Credit in Anhra Pradesh," Indian Journal of Agricultural Economics, Vol. XXXIII, No. 4, October-December 1978.

This paper attempted to forecast the demand for short-term farm credit in selected districts of Andhra Pradesh. Regression models for each district were estimated based on time series data from 1966-67 to 1975-76. Oil engines, yield value per hectare, and fertilizer were found to be significant explanatory variables of credit demand for this period.

Schluter, M. G., "The Interaction of Credit and Uncertainty in Determining Resource Allocation and Incomes on Small Farms, Surat District, India," Occasional Paper No. 68, Department of Agricultural Economics, Cornell University, February 1974, ACTS No. 1860

The study investigated the effects of credit and uncertainty on farm allocation among 120 farmers in Surat district in India using both econometric and programming models. The role of credit availability and uncertainty was analyzed by estimating demand functions for labor, modern varieties, fertilizer and livestock where these variables were explicitly specified in the equation. Quadratic programming model was applied to determine the effects of capital constraint, and uncertainty on choice of cropping pattern.

Schluter, M. and G. P. Parikh, "The Interaction of Cooperative Credit and Uncertainty in Small Farmer Adoption of the New Cereal Varieties," Artha-Vikas, Vol. 2, No. 2, July 1974, ACTS No. 914.

The authors investigated the impact of credit on the adoption of the new seed-fertilizer technology among 345 farmers in the Gujarat State of India in 1969-70. An adoption model of the new seed-fertilizer technology was estimated econometrically where credit and other independent variables such as acreage, income, number of family members, education were specified. Credit was a significant factor and it was more important for the adoption of new rice than new wheat varieties.

Scobie, G. M. and D. L. Franklin, "The Impact of Supervised Credit Programs on Technological Change in Developing Agriculture," Australian Journal of Agricultural Economics, Vol. 21, No. 7, April 1977, ACTS No. 1500.

A conceptual framework for analyzing net social benefits of supervised credit program was presented. Using farm level data for Guatemala, the study also measured the farmer's cost of following fertilizer use regulation and tested whether fertilizer use regulations affected farmer's resource allocation.

Silva, Z. P., "Uso e Eficiencia do Credito Rural e dos Fatores de Producao," Unpublished M.S. thesis, University of Sao Paulo, 1973.

The effects of credit in resource allocation and productivity were determined using a sample of 129 farms in Jardinopolis and Guaira in 1969-70 and 1971-72. It was hypothesized that use of credit would affect farm productivity through operating expenses, modern inputs, and farm machinery. The hypothesis was examined by estimating a Cobb-Douglas production function with variable elasticities of production for these three inputs.

Singh, G., "Farm Level Determinants of Credit Allocation and Use in Southern Brazil, 1965-69," Unpublished Ph.D. dissertation, Ohio State University, 1974.

The characteristics of institutional and non-institutional borrowers in Southern Brazil in 1965 and 1969 were described in terms of farm size, operating expenses, investment expenses, cash agricultural income, inventory and assets, credit used, and selected financial ratios. Changes in the distribution of credit by farm size between the two periods were reported. A number of existing econometric studies of credit demand and supply functions were also reviewed.

Singh, Inderjit and Choong Yong Ahn, "A Dynamic Multi-Commodity Model of the Agricultural Sector: A Regional Application in Brazil," European Economic Review, Vol. 11, 1978, pp. 155-179.

Authors presented results of policy analysis for Southern Brazilian agriculture using a recursive linear programming model. Alternative agricultural policies were studied including changes in interest rates for formal credit. The derived demand for credit was calculated in the aggregate and for three farm size groups.

Singh, R. and A. S. Kahlon, "Capital and Credit Requirements of Farms at Different Levels of Mechanization," Journal of Research, Vol. 10, No. 6, December 1973.

This study estimated the impact of credit on farm income under these mechanized technology in Punjab, India. Linear programming models were constructed for six farm groups classified by farm size and level of mechanization. The study reported the implied returns of fixed resources in programming with and without capital-borrowing.

Soares, A. C. de M., "Resource Allocation and Choice of Enterprise Under Risk on Cotton Farms in Northeast Brazil," unpublished Ph.D. dissertation, Ohio State University, 1977.

Objective of study was to determine resource allocation and enterprise mix on large sharecropped farms. Quadratic programming was used. Sensitivity analysis was conducted by changing technology, cotton prices, wages, availability of temporary labor, and borrowing limits for formal credit. A 50 percent reduction in borrowing limit reduced sharecropping and farm income, while increasing variance in income.

Spellman, L. J., "Economic Growth and Financial Intermediation," and also the comment by C. Gonzalez-Vega in Money and Finance in Economic Growth and Development, Essay in Honor of Edward S. Shaw, ed. by R. I. McKinnon, Marcel Dekker, Inc., 1976.

The implications of the introduction of a financial system in a standard macroeconomic growth model on equilibrium values of the investment share of output, capital intensity, interest rate, per capita output, and per capita consumption were analyzed. The model was also used to study the aggregate effects of deposit and loan rate ceilings typically found in LDCs.

Staub, W. J., C. D. Alexander and C. Saleh, "The Market for Production Credit Among Farmers in Java," PRISMA: Indonesia Journal of Social and Economic Affairs, No. 3, May 1976.

The paper estimated the potential impact of variations in operational policies of the BRI-BIMAS credit program in Indonesia in farm income and demand for credit. Linear programming models were specified for six representative groups of farms classified by farm size and liquid capital based on farm survey data of 62 farms in a village in West Java. The specific policy variations examined related to credit allocation among small vs. large farmers, time of repayment, form in which credit is disbursed, and interest rate.

Subrata, G., Rural Money Markets in India, MacMillan of India, 1976.

One of the chapters of the book was devoted to explaining the factors affecting demand for credit in India using district level data from the All India Rural Credit Surveys in 1951-52 and 1961-62. Demand for credit was related to family expenses, farm capital investments, farm operating expenses, and nonfarm business investments. Borrowing was found to be positively related to assets.

Technical Board for Agricultural Credit, Financing Agricultural Development: The Action Program (Agricultural Credit Plan CY 1977-82), Philippines, 1977.

The first part of this document described the historical role of agricultural credit in the national economy, trends in its supply and allocation patterns, and general policy and program setting. The second part presented the national indicative agricultural credit plan which specified the objectives, strategies and policies with respect to agricultural credit projects, national, regional and sectoral credit requirements and supply of funds for 1977-82, and explained the program of implementation, monitoring and evaluation of the plan. The credit requirements were projected primarily by farm budgeting techniques, i.e., based on estimates and fundamental assumptions about cost of production and proportion of cost financed by credit.

Tewari, S. K. and J. S. Sharma, "Impact of Credit and Crop Insurance as Liquidity Management Strategies Upon Adoption of Modern Technology and Income Levels on Small Farms in India," Journal of Agricultural Economics and Development, Vol. VIII, No. 2, July 1978, pp. 194-204, ACTS No. 1859.

Authors analyzed formal agricultural credit and crop insurance as factors affecting liquidity management. The theoretical expected relation between value and quantity of reserves underlies the analysis. A linear programming model was developed for a representative small farm under 7.5 acres studied in U.P., India. Alternative credit and crop insurance assumptions are studied for their impact on farm production and income.

Tinnermeier, R. L., "Agricultural Credit Demand - A Discussion," Paper presented at Workshop on Rural Finance, Dominican Republic, Dec. 1978.

This paper reviewed some of the problems associated with estimating credit demand. Some of the common methods which have been used to estimate farmer credit needs such as farm budgeting, ratio/trend analysis, flow of funds, and linear programming were also analyzed.

Tinnermeier, R. L. and M. G. Finn, "The Impact of Small-Farm Credit in Peru," in George F. Patrick and others (eds.), Small Farm Agriculture: Studies in Developing Nations, Station Bulletin No. 101, Sept. 1975, Department of Agricultural Economics, Purdue University.

The effects of supervised credit program in Peru were investigated based on the experience of 279 farmer-borrowers. The levels of input use, productivity, and income between 1967 and 1969 were compared. The authors concluded that the program had only minimal impact on the adoption of fertilizer, crop productivity, and income levels.

Vasconcellos, Marco Antonio Sandoval, "A Influencia de Restricoes de Credito na Organizacao da Producao Agricola," Colecao Analise e Pesquisa, Vol. 13, Comissao de Financiamento da Producao, Ministerio da Agricultura, Brazil, April 1979.

This study used the profit function approach to analyze resource allocation on a sample of 462 farms located in southeastern and southern Brazil. The firms were separated into groups with and without financial constraints. The estimates for farms with financial constraints showed suboptimum resource use.

Whitaker, Morris, J. R. Loidan and Thomas Walker, "Supervised Credit: It's Impact on Profits, Production, Factor Use, Technical Change and Efficiency of Resource Allocation in Corn Production in Colombian Agriculture," Analytic Working Document No. 8, Sector Analysis Division, Bureau for Latin America, AID/Washington, March 1973, ACTS No. 1276.

The impact of the INCORA credit program in Colombia from 1968-70 was evaluated by determining the levels of production, profits, factor use, and technology in the absense of INCORA credit for working capital by linear programming. The difference between the current situation as revealed in the data and the solution to the program is attributed to the credit program. The effect of loan use regulation was also examined using the same approach.

White, T. K., "Credit and Agricultural Development - Some Observations on a Brazilian Case," in G. Patrick, Small Farm Agriculture: Studies in Developing Nations, Station Bulletin 101, Department of Agricultural Economics, Purdue University, Sept. 1975, ACTS No. 1183.

The paper described the structural and functional characteristics of formal agricultural credit institutions and programs. The results of five Masters' theses which identified the factors affecting use of credit as a means of increasing profit were also summarized. In these studies, linear programming models were used specifically to analyze effects of varying borrowing capacity, available production-investment opportunities, interest rates, and special credit programs on optimal credit use based on coefficients for typical farm structure in three subregions of Zona de Mata.

World Bank, Operations Evaluation Report: Agricultural Credit Programs, Vols. I and II, World Bank, November 18, 1976, ACTS Nos. 1333 and 1334.

These two volumes evaluated the performance of a series of World Bank credit projects in Mexico, Uruguay, Morocco, Pakistan and the Philippines. The projects were evaluated in terms of their stated objectives of increasing productivity, improving equity and developing institutions. The study was based on existing analysis and farm survey data collected for this purpose. A total of 1,125 borrowers and nonborrowers were studied ranging from 196 in Pakistan to 244 in the Philippines.

Young, Chul Kim, "A Study of Credit Use and Resource Allocation on Small Farms: A Korean Case," Unpublished Ph.D. dissertation, Andhra University, India, 1978.

The study examined the role of credit in production by comparing the degree to which resources are efficiently allocated between farms who use relatively more credit (non-subsistence farms) with those who don't (subsistence) based on a survey of 207 farms in Korea. In addition, the factors affecting repayment rate were also studied.